

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

ASD/

A85-J6

Department of
Agriculture

Joint Council on
Food and
Agricultural
Sciences

June 1995

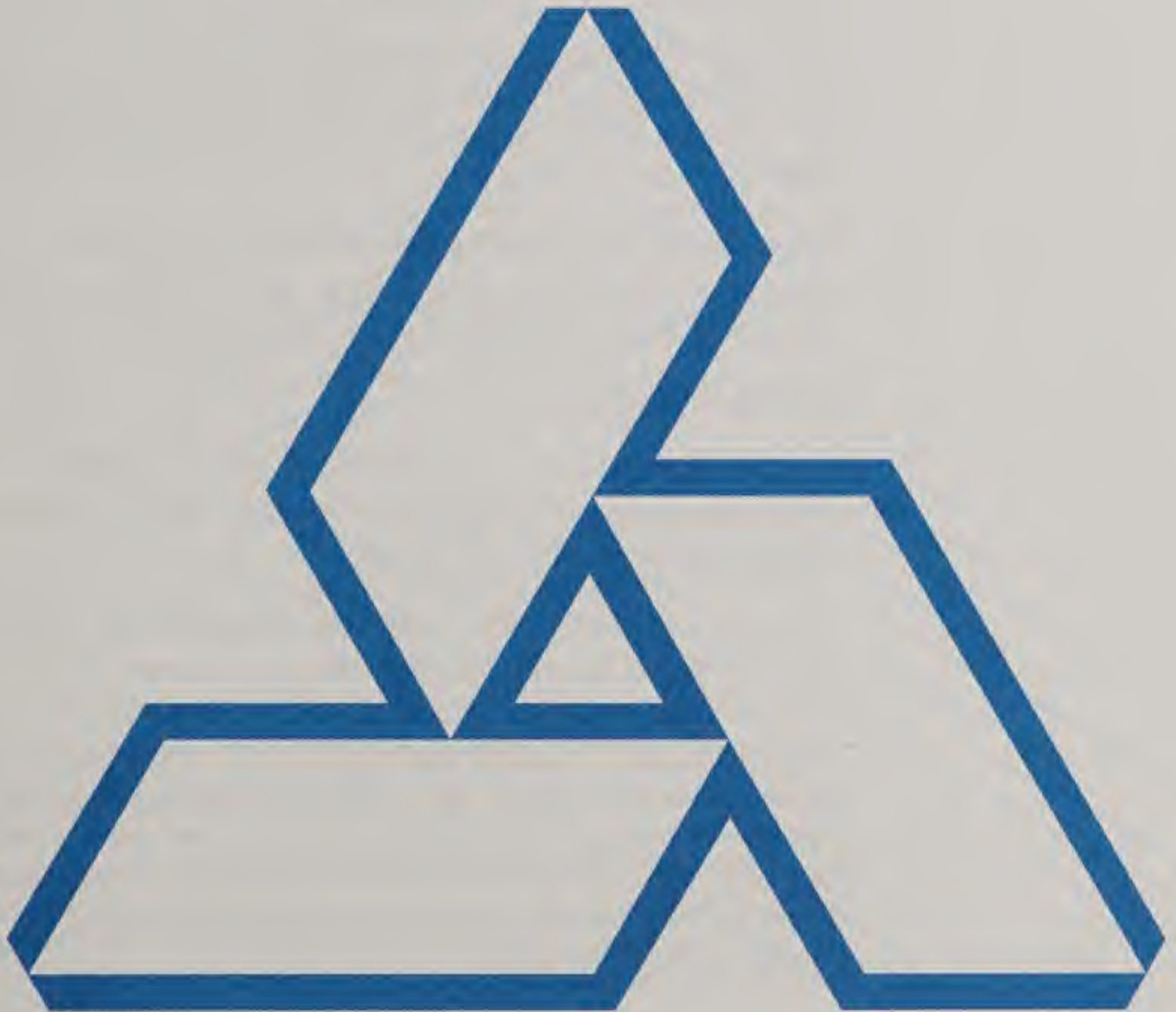
1995 Accomplishments for Research, Extension, and Higher Education

A Report to the
Secretary of Agriculture
and the U.S. Congress



1995 Accomplishments for Research, Extension, and Higher Education

A Report to the
Secretary of Agriculture
and the U.S. Congress



Preface

Agriculture has built and crushed civilizations. That is something we must not forget.

Imagine a developed country today without a science infrastructure supporting its agriculture and forestry, perhaps a new country in an area of upheaval. There might be universities, government institutes, and other resources scattered here and there. But to survive in the environment of the late 20th Century the citizens would need an integrated system that applies research to producing, distributing, and selling food and fiber. They would need basic research, but also more focused science working for them.

Thanks to the vision of our forbearers, the United States has this key block in its foundation, a U.S. Department of Agriculture and land-grant university partnership that goes back more than a century. It is one of our country's biggest competitive advantages in the global village.

Our partnership of the USDA and universities in every state generates new knowledge, communicates that knowledge to those who need it, and continually educates new generations.

How does it do this?

At the grassroots, the nationwide Extension Service network identifies opportunities and problems for researchers and delivers findings back where they are needed.

The research comes from the USDA's Agricultural Research Service (ARS) and Forest Service, from Agricultural Experiment Stations at Land-grant universities in every state, and from projects commissioned at other universities. The research is conducted, often jointly, at the local, regional, and national levels. New knowledge produced by research complements and adds to the curricula at land-grant universities, better preparing future generations to continue solving problems facing consumers of food and fiber, and the industries which serve them.

Today's Competitive Edge

The Joint Council on Food and Agricultural Sciences was established by the 1977 Farm Bill and has the mandate to advise the Secretary of Agriculture on the strategy and annual priorities for agricultural research, extension, and higher education. In addition, the Council is required to provide an annual assessment of progress toward accomplishing these priorities.

In this report, the emphasis has been placed on stating the impact of the products of the research, extension, and higher education programs in outcome-oriented terms. Where possible, examples were cited that state these outcomes in specific, quantitative terms. The effort has been to say exactly how the results of these programs have been applied and to identify the specific beneficiaries. It is recognized that with the current emphasis on federal deficit reduction, it is more important than ever to clearly state the rationale for existing programs and to demonstrate their utility in addressing problems and opportunities that truly represent national issues and that are the business of the federal government.

This report provides a brief statement of the overall continuing utility of the USDA programs in research, extension, and higher education. It addresses the state–federal partnership activities administered under the Cooperative State Research, Extension and Education Service (CSREES) as well as the intramural programs of the Department including the ARS, the Economic Research Service, National Agricultural Statistics Service, and the U.S. Forest Service.

Following an Executive Summary, the first section of the report presents a brief overview of the rationale and payoff of the total USDA system. It describes this in terms of the new knowledge and technology needed to maintain and enhance the competitiveness of U.S. agriculture and to provide the citizens of this country with safe, wholesome food.

The second part of the report uses 15 examples to show specifically how the USDA programs in science and education have created opportunity and solved pressing problems to enable science–based production, processing, and delivery of food, fiber, and forestry products.

Executive Summary

The USDA research, extension, and higher education programs consist of interrelated complementary programs of intramural research coupled with a unique state–federal partnership of research, extension, and higher education. National priorities evolve from aggregated grass roots needs and opportunities. Members of the partnership plan and execute national programs in the context of regional and local applications. The overall system serves as a model for federal involvement in national research with devolved local decision making and cost sharing.

The following text illustrates the impact of the state–federal science and education partnership on 15 broad societal issues. Examples have been drawn from the vast portfolio of activities reaching across the entire United States and involving a spectrum of activities from the specialized intramural national laboratories of the Forest Service and ARS, to the regional, state, and county level activities of this state/federal land-grant university partnership.

Viable Production Systems Compatible with Environmental and Social Concerns

Winning the War on Pests

Pesticide use is down. And production is up. That translates into something good for everyone.

The Ecosystem: Managing the Big Picture

Nutrient management plans reduce fertilizer use. Soil erosion has been reduced, and wildlife management has been enhanced.

Whole Farm Systems — For the Long Run

Prescription farming and other whole system management techniques reduce unit cost and increase production.

Turning Liabilities into Resources

Waste recycling can increase crop yields and save fertilizer costs.

A Safe, Affordable, Reliable, and Nutritious Food Supply

Ensuring Safe, Wholesome Food for All Citizens

Rapid analysis techniques help detect pathogens before food is sold. Better training for food handlers helps keep the products clean.

Good Diet: America's Best Health Care Plan

Diets are improving, and consumer health and finances are better for it. Lower fat, improved availability of vitamins, and more exercise are part of the reason.

Safe Food: It's in the Process

Improved packaging, preservation, and education all contribute to a successful improvement in food safety along the processing route.

Future Challenges Met by Science and Education Working Together

Planting the Seeds of Knowledge

Curriculum enhancement through stronger ties to both industry and societal needs offers university graduates a chance to begin solving tomorrow's challenges today.

Improving the Competitiveness of the U.S. Food and Natural Resource System

Genetic Enhancement: Making the Most of Nature

The value of genetic enhancement is incalculable. It brings solutions to human, animal, and plant diseases. It reduces production costs at the same time as it reduces consumer costs.

Animal Health and Wealth

Research and education are contributing to the health of livestock, to increased safety of food products, and to a reduction of animal suffering.

Making More Out of Much: New Uses of Agricultural Products

Crayons from soybeans and cushions from corn. Super-slurping starches and granite-like counter tops. All are agricultural products many consumers are surprised—and pleased—to find.

A World of Markets — A Competition

Policy development and international consumer demands result in longer shelf-life for beef, certified viral-free swine, and stronger wheat protein.

Improving the Lives of Individuals, Families, and Communities

No More Fences: Agriculture and Urban America

It's a two-way street. Urban needs find solutions in agricultural practices, and rural concerns are met with urban solutions.

Giving the Grow to Rural Communities

From job and revenue increases in rural New Mexico to more doctors in rural Georgia, rural America's strength is returning.

Help for Our Future Is a Family Affair

Medicare costs are reduced with more healthy babies. Improved grades in school increase self-esteem and prevent future social costs.

The Case for Continuing Federal Support of Agricultural Research, Extension, and Education

- **The primary beneficiary of federally sponsored agricultural research, extension, and education is the consumer.**

The results of these programs affect the well-being and quality of life of every person in this country. The average consumer pays 11.4% of annual income for food, less than in any other country. Although improvements are being made, the U.S. also has the safest food supply in the world. Research and education continue to have a major positive impact on the industries that produce food and fiber, and on the citizens who benefit from this system.

- **Agricultural research and extension are central to food and fiber production, one of the largest industries in the U.S.**

Agricultural research and extension provide the knowledge base and technology development that allows the food and agriculture system in the U.S. to provide one of the largest offsets of the foreign trade deficit, more than \$40 billion per year. The food and agriculture industries provide almost 20% of U.S. jobs. Food and fiber products generate nearly one trillion dollars in gross domestic product (GDP)—about 16% of the U.S. total.

- **Agricultural research, extension, and education are needed more today than ever before.**

Despite the success of American agriculture over the last century, there are unprecedented needs for new knowledge and technology today. Ensuring that the food and agriculture system is increasingly competitive in the international marketplace, while maintaining an appropriate interface between production and environmental concerns has been increasingly recognized by Congressional leaders as a primary issue in the Farm Bill debate. Similarly, the need for science-based improvements in human nutrition and food safety have highest national priority.

Meeting these needs requires producing better and safer food, finding new uses for agricultural products, reducing use of expensive and potentially damaging chemicals and loss of natural resources through erosion or degraded quality, and better understanding the needs of international customers. The contemporary agenda for agricultural research, extension, and education is dramatically influenced by these needs.

- **Federal formula funding, coupled with state and local appropriations for agricultural research and extension is an excellent model of decentralized decision making with joint federal–state planning and flexibility to take specific actions at the grass roots level.**

Funds provided under Hatch, Smith–Lever, Evans–Allen, and McIntire Stennis legislation are appropriated on a formula that reflects the size of agriculture and forestry in each state. States match, or more than match, federal funds. While overall goals are set by consensus between state and federal partners, this funding arrangement exemplifies the spirit and intent of assuring decision–making close to the people and their issues. Administrative costs are less than 5% of federal appropriated funds. This approach, which has a remarkable continuing track record of success, is more than a simple block grant, it is a unique state–federal partnership that must be sustained.

- **Federal funding for agricultural research, extension, and education requires a balanced portfolio of formula funds, special grants, and competitive grants.**

This combination funding assures appropriate federal investment in research and extension of results for the spectrum of activities addressing national issues. And, it involves the federal government in high risk agricultural research that brings the breakthroughs of tomorrow while providing for the urgent needs of today. Funding for higher education in USDA helps provide the next generation of farmers and scientists who are so vital to the food and agriculture system.

- **The efficiency of the federal–state–local partnership for agricultural research and extension is very high.**

Each federal dollar appropriated for agricultural research, extension, and teaching leverages 4–5 state, local, and private dollars. The federal funds are the “glue” of the partnership. There is a measured annual rate of return on the overall investment in research and extension of between 30 and 50%, depending on location and commodity. The partnership assures that critical national issues are addressed at the local level, avoiding the concept of “one size fits all.”

- **Agriculture does not stop at the farm gate, nor should agricultural research, extension, and education. They serve constituents along the entire food and fiber chain — from gate to plate.**

Processors, distributors, marketers, and policy/decision makers concerned with rural economic development all use the continuing stream of new knowledge and technology developed through research and extension activities. Studies of human nutrition and food safety help to set standards for production agriculture. Development and delivery of knowledge on youth and family vitality are also a critical parts of the extension agenda.

Interrelationships and Synergies

Four Major Points

- The USDA state-federal partnership is a unique way of addressing national priorities in a devolved system of shared responsibilities. It could be emulated by other parts of government to achieve the goals of the Congress and Administration in empowering local decision making and appropriate sharing of fiscal responsibilities.
- The three-way relationship between research (new knowledge), extension (assured application), and higher education (creating the next generation of implementers) is distinctive to agriculture. The mutual support and interdependencies create a synergy that is unparalleled.
- The federal and state (intramural and extramural) activities are jointly planned and complement each other as part of an overall USDA investment strategy.
- Federal funds invested in the state–federal partnership are highly leveraged (4–5:1).

Examples of Impact by Research, Extension, and Higher Education

The National Committees and Regional Councils of the Joint Council recommended topics for this annual accomplishments report. These topics were aggregated under a set of 15 overarching impact areas. The following pages look across a time span of about five years in each of these areas to develop a broad perspective about what has been accomplished and the resulting impact.

For each of the examples, general impact statements are followed by specific examples that show what was done and how new knowledge and technology are being used. The examples are illustrative but do not fully cover the broad spectrum of programs falling under the responsibility of the USDA Under Secretary for Research, Education, and Economics. They were chosen as samples. The states and locations were chosen to illustrate that many different research, extension, and teaching centers are involved in finding and applying answers to society's most pressing needs.

To be effective and to address needs delineated directly by society rather than following arbitrary internal lines, cooperative efforts between state-based university scientists, specialists, and instructors, and similar professionals in ARS, Forest Service, and others agencies are required.

These are their stories in service of America's people.

Winning the War on Pests



Pesticide use is down. Pests are being turned every which way but loose with integrated pest management (IPM) — a dollar-wise, environmentally friendly approach that pits genetics, new cultural practices, and natural enemies against insects and diseases.

IPM Saves Big Bucks, Jobs

Integrated pest management (IPM) anticipates and prevents pests from reaching damaging levels by using a mix of natural enemies, pest resistant plants, cultural manipulations, and minimal chemical pesticides. It works!

- Texas studies show a savings of 20,000 jobs and a \$1.5 billion annual savings in pesticide applications from IPM. Insecticide use on cotton has dropped from 29 million pounds to 2.3 million since the 1960s; vegetable growers have increased profits by \$22,000 an acre in these high-value crops; disease-resistant wheat varieties lowered pesticide costs on that crop by \$18.5 million annually.
- In Utah, growers saved more than \$8 million over the past five years, as more than 70 percent have switched to IPM strategies.
- U.S. and Australian scientists have produced the first insect-resistant seeds. They removed a gene from a bean that prevented weevils from digesting its starch and moved it into a variety of garden pea that lacked resistance to the pest. The same technique can be used on other crops, thus preventing multi-billion-dollar storage damage by insects.
- USDA-ARS researchers have released three corn lines with super resistance to the European corn borer, the world's most devastating corn pest. The pest costs up to \$1 billion annually in the Corn Belt and hurts food and feed on four continents.
- University of Missouri scientists developed the only soybean variety (Hartwig) resistant to all known races of soybean cyst nematode, a fast-spreading pest that causes \$400 million worth of damage annually.

Payoff

- **Fewer pesticides.** The amount of herbicide- and insecticide-active ingredients applied to crops has gone down considerably, thanks to university extension pesticide education and applicator training. Midwest researchers report a 38 percent reduction in pesticides on soybeans, corn, wheat, and milo in the last 15 years.

Winning the War on Pests...

- **Lower costs; more good bugs.** Midwest farmers are lowering production costs \$2.18 to \$4.35 an acre by using lower levels of insecticides as recommended by extension specialists. The lower levels of insecticides also increase the numbers of beneficial insects left in the field to help control pests.
- **Show-Me monitor forecasts disease.** Missouri researchers developed a weather monitor that forecasts plant diseases. Bottom line: It cuts pesticide use for farmers and gardeners by telling when plants are susceptible to disease or insects. The heart of the system is a field weather station that transmits weather data to a computer programmed with "disease prediction models."
- **Melon monitor tells when to spray.** Purdue plant pathologists created a microprocessor that senses leaf wetness and temperature in melon fields, then predicts when growers need to spray for *Alternaria* leaf blight. The system saves 3 to 4 sprays a year. That saves a grower with 50 acres \$1,500 worth of spraying costs and reduces fungicide applications by 188 pounds annually.
- **Pesticides that stick.** Now available commercially are USDA ARS-invented granules of cornstarch-encapsulated pesticides that stick to plant leaves. The technology includes a formulation that uses bacteria to kill corn borers.
- **Sex and beetle juice.** Bad beetles are falling into a tender trap baited by the smell of synthesized sex attractants and the scent of fermented fruit. Once in the trap, fruit growers and warehouse managers get information they need for effective insect control. ARS scientists made the "aggregation pheromones" to mimic those of the dried fruit beetle.
- **Moth-eaten?** Newest introduction to control codling moth in fruit is a fuzzy half-inch-long fly introduced from South Korea by ARS. The fly does bad things to the moth — and only the moth. ARS and universities in tree fruit regions, such as Oregon, are using what they call the "Chanel No. 5 method." Plastic tags soaked with female moth sex hormone are placed in trees, confusing males so they don't mate, which means no larvae to eat the fruit.
- **Thistle down.** Musk thistle numbers have been reduced by almost 90 percent with two kinds of thistle-eating weevils. Benefit? Well, in just one 12-county area of Missouri alone, that saves the highway department \$73,000 a year in thistle control.

The Ecosystem: Managing the Big Picture



Making decisions crop-by-crop or species-by-species doesn't work. Actions that affect one type of plant or animal within a forest or a watershed never stop with that plant or animal — there's always a ripple effect that touches every other plant or animal in the ecosystem, including humans.

Looking Beyond

Sound ecosystem management demands consideration of a wide array of variables — such as weather, markets, pest control, fertilization, and natural resource qualities. The rules of the game are becoming so complex that computer-based management systems are often necessary to assure the best decisions. Expert systems have come into use through research and education.

Those concerned with environmental policy must look at the impact of individual farms or enterprises on rivers and stream basins, estuaries and water supplies, and ultimately on total ecosystems. Examples of the pitfalls of a single-focus decision are as close as the newspaper headlines. Consider the spotted owl controversy: In an effort to protect owls living in the Northwest's old-growth forest, logging in the area was brought to a virtual halt, with enormous economic impact on the region.

Forestry and agricultural management decisions are complicated by society's often conflicting demands. Americans want to preserve ecosystem biodiversity, but they also want affordable lumber for housing and furniture and an abundant, reliable food supply from the land — delivered in an aesthetically pleasing manner. The population demands increasing production of goods from an ever-shrinking landbase.

How do we achieve this ecological juggling act? The answer is ecosystem management — described by one observer as “finding ways to take better care of the goose that lays the golden eggs.” Crucial to this is a better understanding of how the ecosystem really works — the relationship of plants, animals, and their environment over a large scale. To achieve this, researchers, producers, and the public must reach beyond preconceptions and ecological myths and learn how the ecosystem really functions.

Payoff

The pressures are great on those who must meet society's demands for increasing productivity without treading on nature's toes. Here are some ways research and education are working together to achieve that goal:

- **A total management approach** has headed off trouble on a Georgia watershed with the state's highest potential for agriculturally caused nonpoint source pollution. A USDA water quality project on the watershed was designed to increase voluntary farmer adoption of Best Management Practices to

The Ecosystem...

protect and improve surface and ground water. To date, 77 nutrient management plans have been completed to help farmers place the nutrients from animal waste on growing crops. More than 42.2 million gallons of lagoon effluent have been spread over growing crops without known surface or ground water contamination.

- **An inexpensive white powder called polyacrylamide (PAM)** helps hold things together when fields are irrigated. Irrigation is an accepted farming practice, but it carries a price: up to 2 billion tons of soil wash off the world's 600 million acres of irrigated croplands every year. When PAM is applied to soil, irrigation water slides away from soil particles as the water flows down a furrow, virtually eliminating erosion and the resulting pollution of runoff water. Federal researchers in Idaho reduced sediment loss up to 97 percent by using PAM. An added benefit: fertilizers and other chemicals stay put, rather than washing away. Enough PAM to treat about 27,000 gallons of water costs only \$2 to \$3 per acre.
- **When the deer and antelope play, other animals may suffer.** Scientists in Indiana showed that when deer are given free rein, they wipe out as much as 90 percent of plant species and ground cover that provide food and habitat to birds and small animals. Among the options: trapping and moving the deer, birth control measures, fencing, supplemental feeding, and bringing back predators. The most practical approach, however, is limited hunting periods to reduce the deer population.
- **The U.S. Forest Service has made one of the more profound changes** in management paradigms emerging on the environmental agenda: going from an essentially forest harvesting focus to an ecosystems management concept in which economics, environment, and ecology are considered in a systems approach to optimize the use of natural resources. Research to define the new rules for total ecosystem management is still being generated.
- **Computer models are helping clean up water** by predicting how nutrients and pesticides move down through plant rootzones in a field. A Purdue agricultural engineer has built on USDA data and computer models to make the predictions. The new information will become part of national and state computer maps that can pinpoint potential water quality trouble spots. The engineer used components of a state and national Geographic Information System that includes separate computer maps of such things as land use, agricultural statistics, cropping patterns, fertilizer use, soil properties, and elevation.

Whole Farm Systems — For the Long Run



What good is farming if it can't be profitably maintained and environmentally friendly? No good, that's what. So agricultural scientists and extension specialists have taken whole-farm strategy to keep agriculture viable in the long run.

Among the Tactics:

Integrated pest management — IPM offers a balanced attack — cultural practices, biological control, resistant varieties, and a minimum of chemicals — to take insects and diseases out of the ball game.

Agroforestry — This practice of growing trees, farm crops, and livestock on the same land at the same time creates a synergism between agriculture and natural resource management. It's profitable, saves soil, and improves wildlife habitat.

Prescription farming — Some call this "farming by the grid" or "precision farming." Fields are divided into small sections or grids, and each is tested to see what it needs. Then, using high-tech sensors, farmers precision-apply fertilizers, irrigation, and pest controls to each spot only as needed.

Payoff

The harvest from whole-farming systems is being reaped from coast to coast. Here are a few examples:

- Missouri farmers like their profitable version of agroforestry called "alley cropping." Cattle graze between rows of walnut trees, while the trees produce nuts and eventually timber. (Footnote: thanks to agroforestry on some land and conservation tillage practices on others, Missouri cut its annual erosion rate in half in the last 12 years! Ohio claims a **90 percent reduction in erosion** from conservation tillage alone.)
- Rice research in Texas that reduces the crop's water, pesticide, and fertilizer requirements **saves Texas \$7 million and the U.S. \$187 million annually**. Similar efforts with Delaware vegetable growers have reduced their input costs by \$25 to \$40 an acre.
- Connecticut's extension training of 77 growers, grounds-keepers, and consultants **decreased pesticide use by 32 percent** — a savings of \$90,000. At the same time, yields of fruit, field corn, and poinsettias were doubled; turf yield increased 88 percent; vegetables, 75 percent.

Whole Farm Systems...

- Forty farmers in Missouri's Bootheel divided land into small portions or grids, then analyzed each for soil and crop needs. They found a **75-bushel difference in corn yields** in some fields — a difference they could correct in their favor by prescription application of fertilizer and irrigation to meet those needs.
- The Seco Water Quality Demonstration Project in Texas encourages producers in three counties to voluntarily adopt range management practices to protect the Edwards Aquifer. The project increased water recharge by 50,000 gallons annually; **cut pesticide use in half; reduced fertilizer use by 160,000 pounds and decreased use of other chemicals by 40,000 pounds**; and increased irrigation on farmland by 10 percent.
- Cotton growers use an ARS system called WHIMS for (W)Holistic Insect Management System to find where, when and how much pesticide is needed. WHIMS is compatible with ARS-designed GOSSYM/COMAX, a crop management system now used on more than 500,000 acres of commercial cotton. A similar weed computer model for corn, WEEDCAM, has **generated \$65 to \$120 more income per acre**.
- Five Connecticut **poultry producers saved up to \$10,000 a year** by following extension recommendations for energy-efficient ventilation and lighting systems, manure and dead bird disposal, and insect and rodent control.
- On the Morton farm in Leake County, Miss., an integrated program by extension specialists, veterinarians, and beef industry representatives has increased calving rate from 70 to 90 percent and weaning weight from 398 to 520 pounds — an **increase in net income of \$77 per cow**.
- Maryland extension nutrient management consultants developed 1,448 new farm fertilizer plans and updated 1,184 others in 1994. Result: nitrogen **savings** of 2.9 million pounds **worth \$720,000**. On Wicomico County farms alone, in a program started in 1989, total savings of nitrogen, phosphorus, and potash have been more than \$565,000.

Turning Liabilities Into Resources



America's \$30 billion a year poultry industry produces enough poultry litter annually to pave a two-lane highway, three feet deep, that would reach from Santa Barbara, California, to Washington, D.C. Such a highway may seem like a roadblock to society's progress, but science is showing it may really be a road to riches.

Waste Makes . .

The U.S. poultry industry produces an estimated 20 million tons of poultry litter (manure, bedding material, feathers, and other debris that collect on poultry house floors) each year. The industry also produces at least 3,200 tons of dead birds each week. The U.S. cattle industry produces more than a billion pounds of manure each day. American consumers throw away 1.6 pounds of paper per person each day, constituting about 40 percent of the trash in landfills. Yard wastes take up another 15-18 percent of landfill space.

Managing waste products in an economical and environmentally sound fashion is a big problem and a huge expense for municipalities and agricultural producers and processors. But science has found ways to turn those "problems" into valuable solutions. In fact, research is showing that, by treating waste as a resource, farmers and municipalities can make money, improve production and sustainability, preserve and enhance jobs, and protect the environment.

Agricultural research and education efforts based in the land-grant system are helping find new uses for waste products such as fertilizers, livestock feeds, fuels, biodegradable plastics, and many other products. Educational efforts and cooperative work with other federal and state agencies are ensuring that this information is being put to use.

Payoff

The following are a few specific examples of how land-grant/USDA efforts are translating into positive things for citizens nationwide.

- In Alaska, agricultural researchers recently completed a field study that proved organic **municipal solid waste can effectively be used to reclaim gold mines in the subarctic**. The option of using a waste product to reclaim wasteland is of interest to both miners and municipalities. Scientists in other states have found that sewage and papermill sludge can be used to help reclaim abandoned mines. And, with fertility adjustments, using reclaimed mine land for pasture may be possible.
- A Delaware study has shown that **coal fly ash**, a by-product of the electric power industry, **can increase crop yields on sandy, drought-prone soils**. Coal ash can enhance soil quality, while also supplying plant nutrients. Ohio scientists are developing high-volume and high-value uses for coal-burning by-products, such as building roads and embankments.

Turning Liabilities Into Resources...

- To protect groundwater and surface water against pollution from agricultural production, research and extension efforts have enlisted **47 percent of Delaware farmers to use covered manure-storage structures**, and 43 percent of the Delmarva Peninsula's 6,000 **poultry houses are served by dead-bird composters**, up from 18 percent in 1993 and 9 percent in 1992.
- In many states, extension and research experts reached millions of people through information campaigns to teach them about composting and recycling yard and garden waste, paper, and other products. They also reached thousands of farm families to show them ways to compost manure and dead animals so these items could be used for fertilizers and soil amendments. **Many states are using composted birds as fertilizer, sources of biodegradable plastics, and for other uses.** In Maryland, composting is currently being used for residues from seafood waste, municipal solid waste, yard waste, and other organic materials. In a Washington project, waste from fishing industries is composted with wood waste.
- Connecticut extension agents have been working with horticultural and dairy producers to **help them recycle plastic and polyethylene that they use on their farms.** Thus far, they have acquired more than 500,000 pounds of plastic to recycle, which has saved producers money because they have to buy less plastic and don't have to pay for disposal of that plastic.
- Scientists in Mississippi have developed new timber harvesting systems that allow unmarketable tree parts to be used to make fuel at prices that compete favorably with alternative fuels. The **harvesting systems also saved approximately \$100 per acre** in site preparation costs.
- A pesticide recycling program in Mississippi has expanded to more than 25 counties in the state and to 40 other states. The Mississippi Pesticide Container Recycling Program helps farmers **recycle up to 50 percent of the more than two million empty plastic pesticide containers** generated each year, reducing landfill volume by more than 30,000 cubic yards, while keeping pesticides out of the ecosystem.
- **Constructed wetlands in many states are helping purify livestock and municipal waste water**, cleaning the water so well it can be released into the environment or reused in some farming and industry operations. In addition to cleaning water, the wetlands also are providing new habitat for wildlife.

Ensuring Safe, Wholesome Food for All Citizens



Each year, at least 6.5 million people — or one in 40 Americans — will become sick from food-borne illnesses. And 9,000 of those people will die. Agricultural research and education efforts are helping protect the health and lives of American consumers and also the livelihoods of food producers and processors.

At Home and On the Road

A safe, wholesome food supply is important to everyone, but guaranteeing the safety of every bite we eat is difficult. Food can be contaminated by outside sources, such as chemicals; through sources found in food animals and in their environments; and on our own kitchen counters.

Public and industry concern about food safety is intense. Aside from the physical danger, food contamination is expensive. Food-related illnesses cost an estimated \$4 billion annually in health care costs, lost work time and other direct costs. Costs to the industry due to liability, loss of market share and consumer confidence, and disposing of contaminated food are even larger and much more difficult to quantify.

Though many consumers fear contamination by chemical residues, 90 percent of the food-borne illnesses and deaths are linked to microbiological sources, such as the bacteria *E. coli* 0157:H7, *Salmonella*, and *Listeria*, which can cause severe illness and death, especially in small children, the elderly, and people with weakened immune systems.

Human error at home and in restaurants is the most common cause of food poisoning outbreaks. People undercook meats, cross contaminate different foodstuffs, and neglect to refrigerate food, causing food poisoning. Proper handling and preparation of food items can virtually eliminate safety threats.

But how can consumers and the food industry protect the food supply? A recent Gallup poll showed that 78 percent of those surveyed believed land-grant universities should have a larger role in food safety education. The land-grant/USDA system combines the expertise and resources of university research and education programs at federal and state levels. Answering concerns reduces costs, requires less regulation, and makes our food supply safer than ever.

Payoff

The following are just a few examples of how research and education have a direct impact on food safety issues.

- Using molecular methods such as DNA analysis, researchers at Auburn University are developing rapid, definitive ways to detect the causes of food poisoning outbreaks so patients can be treated effectively. **These procedures also can be used to test food products before sale so pathogens never reach the consumer.**

Ensuring Safe, Wholesome Food for All Citizens...

- ARS researchers in Georgia have shown that inoculating newly hatched chicks with harmless bacteria can reduce the number of harmful bacteria found in a chick's digestive tract by as much as 100-fold. *Salmonella* and other dangerous pathogens occur naturally in the digestive tract of poultry and other meat animals. These pathogens can be transferred to food items during production and processing. **The inoculation procedure allows innocuous bacteria to colonize in the intestine and crowd out disease-causing organisms**, thus reducing the number of harmful bacteria carried by food birds and reducing the potential of transferring these pathogens to consumer products.
- **Food-handling methods improved as much as 85 percent among people who received university-based training** in proper food handling techniques in such states as Florida, Colorado, Connecticut, Delaware, Kentucky, Kansas, New Mexico, Maryland, Pennsylvania, Indiana, Nebraska, and Washington. Extension agents in these states are working with federal, state, and local agencies to train food handlers working with the homeless and low-income families and in child care centers, nursing homes, health care facilities, school lunch programs, restaurants, and other places where food safety is crucial.
- Many members of the Navajo Nation (New Mexico, Arizona, and Utah) do not have continual access to refrigeration. Recently, more than 2,000 food poisoning cases were reported among the 127,000 Navajo residents in one year. To help alleviate this situation, New Mexico State University developed a **bilingual multimedia system to deliver information about food safety**, including information about proper livestock butchering and food preparation and storage techniques. **Food safety awareness among the Navajo Nation increased at least 20 percent**, and Navajo leaders have requested that the project be expanded.
- Scientists in Alabama, Georgia, and other states have developed new ways to treat poultry and beef carcasses to remove harmful pathogens from the skin and surface area of meat products. Various **water baths and acidic substances are effective in reducing the amount of bacteria found on the carcasses**, in some cases decreasing the number of contaminated carcasses **by 90 percent** compared to the methods currently being used by processors.

Good Diet: America's Best Health Care Plan



When it comes to nutrition, spending dollars now can save health costs later. In 1992, Americans spent about \$839 billion for health care — more than \$3,160 per person. Cardiovascular disease, cancer, and diabetes account for \$252 billion. Even small improvements in diet, such as lowering fat intake, can have long-term positive effects on these and other chronic diseases.

Dramatic Duel: Diet vs. Disease

Research at the molecular and cellular level is helping scientists understand the link between genetics, diet, and disease. Current federal nutrition programs provide some of our children, elderly, and poor with nutrition information. Nutrition programs improve the quality of life and save money. Every dollar spent on nutritional education programs can save up to \$4 in Medicaid costs.

Research and extension programs at land-grant institutions and Agricultural Research Service laboratories emphasize nutrition for newborn babies, teens, elderly, ethnic groups, and those at genetic risk. But getting people to adopt new dietary habits is difficult. Programs such as the Expanded Food and Nutrition Educational Program (EFNEP) provide a human link that helps people make dietary changes.

Land-grant institutions and ARS are in the forefront of dietary research and education programs. Although the value of good health is immeasurable, the cost of disease is an increasing burden to employers and workers. Diet can help reduce health care costs. A company of 8,000 employees could save \$20 million in health-care costs over three years, if high-risk employees made dietary and lifestyle changes.

Diet plays a significant role in controlling and preventing many costly diseases. Osteoporosis, a disease that makes bones fragile, affects 20 million Americans — mostly the elderly.

Dietary calcium plays a key role in keeping bones healthy. Osteoporosis can prevent the elderly from living independently. An additional month of independent living could save \$60 billion a year.

Reducing saturated fat or increasing polyunsaturated fat in typical American diets significantly reduces blood cholesterol levels — linked to heart disease that costs Americans \$50 to \$100 billion annually. Cancer costs more than \$72 billion for treatment and lost productivity. Extension programs in nutrition provide the most recent scientific recommendations on how diet, exercise, and early detection help prevent or control many diseases.

Good Diet...

Payoff

- Diet plays a major role in 10 types of cancer. Classes on cancer risk reduction in Maryland helped 93 percent of participants increase their consumption of fresh fruits and vegetables, while 86 percent reported eating more whole grain products. A workshop on the benefits of exercise and weight control in reducing cancer risk helped **46 percent of the participants develop an exercise program, 57 percent reduce their fat intake, and 29 percent lose weight.**
- Responding to consumer demand for lower fat dairy products, University of Maryland animal scientists are exploring ways for dairy cows to produce low-fat milk. Their research has shown that trans fatty acids enable cows to **lower milk fat from the usual 3.7 percent to 2 or 2.5 percent.** Researchers are working to understand the cellular mechanisms by which this works. It may lead to a practical way to naturally produce low-fat milk.
- Reducing calories consumed as fat is a major dietary concern in the United States. In cooperation with a private company, Washington State University researchers have created nonfat substitutes. They are formed by attaching natural fats and oils to a type of sugar, like glucose or sucrose. The resulting saccharide fatty acid polyesters are changed into fat substitutes. **The nonfat material is non-digestible, nonabsorbable, and noncaloric.** It is substituted for fat or oil in food products such as pork sausages, cheese, and other dairy products. Taste test results suggest that consumers will accept foods containing these nonfat substitutes.
- The level of beta carotene, the precursor of vitamin A, in carrots has doubled over the last 30 years, thanks largely to carrot breeding lines developed by USDA scientists. A new carrot line was recently developed with **five times the beta carotene** content of typical carrots. Farmers may soon be growing them just to extract the beta carotene as a food supplement.
- Food programs often have far-reaching social impacts. Expanded Food and Nutrition Education Programs (EFNEP) in Delaware aimed at 90 pregnant teens and young mothers resulted in reduced infant mortality, lower incidence of low-birth-weight babies, and higher self-esteem among teens. Follow-up of participants showed **80 percent delivered normal birth-weight babies**, five teens returned to school, four took entry-level jobs, and one is in nurse's training. And a **\$156,000 investment** in Purdue's "Have a Healthy Baby" campaign **saved \$3 million** in Medicaid costs over three years.

Safe Food: It's in the Process



What's for dinner? People don't just want to know if food is original or extra crispy. They want to know if their food is safe to eat ... and affordable, reliable, and nutritious.

Safety First

When people sit down to a taste-tempting meal, they don't want to be concerned about illness, bacteria, viruses, or death. Even though only 3 percent of food-borne illness outbreaks are traced back to processing, the numbers of people affected warrant serious consideration.

People hope the processors and the government are taking care of those worries. They're right. That's why the U.S. government spends about \$1 billion a year in regulatory expenses alone to make sure the 275 billion meals Americans consume every year are safe and top-quality.

Yet people still get sick. Some die.

Food-borne disease cases number about 6.5 million annually. As many as 9,000 people die. Americans spend \$4 billion annually for hospital expenses, lost work time, and other direct costs caused by food-borne illnesses.

Land-grant university and USDA professionals try to head off food safety problems in processing and storage by designing packaging to seal out pathogens and seal in quality; by devising computer programs to detect problems; and by ensuring that fish and seafood are as fresh as a seabreeze from the dock to the pot.

Payoff

Here are some examples of what land-grant and USDA professionals are doing to ensure a safe food supply during processing and storage:

- **School in session.** Extension programs in most states report educational efforts to prevent food-borne illnesses. In states such as Connecticut, Delaware, Florida, Georgia, and Texas, consumers, food service handlers, and processors are receiving training. In Delaware, a follow-up study indicated 82 percent of the participants changed at least one food handling practice.
- **Food flashbacks.** Detecting the presence of food-poisoning salmonella bacteria on poultry is coming to the ARS in a flash. Researchers in Philadelphia say electrical current could be a fast tip-off to the dangerous bacteria. Present methods of detection take about 24 hours. If the new method works, it will help ensure contaminated products do not reach the marketplace.

Safe Food...

- **Training the Inspectors.** Texas A&M University hosts the training school for all inspectors and supervisors in the USDA Food Safety Inspection Service. A combination of USDA and university faculty provide cutting-edge training and education to those who are on the front lines of meat and poultry safety during slaughter and processing.
- **Food safety teachers.** Several state extension programs are reaching directly into school classrooms to provide food safety education. The Michigan model added a videotape called "What You Can't See Can Hurt You" to a food safety resource packet for 4th graders in 97 percent of Michigan school districts.
- **Pass the clams.** A Florida study found that 90 percent of seafood lovers surveyed said they are eating fewer oysters and clams, but nearly 70 percent were willing to pay more for mollusks cleansed with purified sea water, a procedure that reduces risks of bacteria and viruses.
- **Safety in a bag.** Fish and other seafoods could be safer and fresher in the iced seafood case. New packaging from Georgia prevents cross-contamination in the seafood case, while other packaging changes color if seafood slips above a safe temperature. Michigan researchers are tailor-making packaging film for various fruits and vegetables to match ideal storage times, temperatures, and oxygen mixtures.
- **The tender touch.** Texas researchers could help improve the Texas meat industry's competitiveness with their promising new automatic meat-grading technology that uses "elastography" to determine meat quality and tenderness. One estimate for turkey processors alone is that a \$300,000 elastographic machine would pay for itself in three weeks for the prompt quality control work it would provide.
- **Hold the salt.** When consumers demand that food manufacturers cut the preservatives, hold the salt or drop the acid in processed foods, a Purdue scientist has a natural substitute. At least two food preservatives of the future give processors the chance to produce low-sodium and preservative-free foods. They could also cut food costs by reducing losses to spoilage and cut health care costs by preventing some cases of food-borne illness.

Planting the Seeds of Knowledge



American agriculture has succeeded so admirably, not necessarily because we have worked harder but because we have worked smarter. Human capital expertise pays big dividends for American agriculture.

Teaching Targets

Theodore Schultz, using agriculture as his model, won the Nobel Prize in Economics for demonstrating that the return on human capital was much higher than the return earned on physical capital. Historically, great proportions of our agricultural work force have been highly educated. Because of this, education has been able to use advanced technologies other countries were simply unable to utilize. But the rest of the world has taken note. Our successful food and agricultural system is being copied. If we are to maintain our superiority, we must continue to invest heavily in human capital to ensure more and greater accomplishments for American agriculture.

To ensure that our scientists and professionals will be able to meet the new global challenges, we are engaged in providing better teaching, better delivery of these courses, better courses and curricula, more and better partnerships, and a more diverse population of students, faculty scientists, and professionals.

Better teaching calls for training, and in many cases retraining, of faculty and scientists. Better delivery systems mean utilizing the best in high-technology instruction, including satellite transmission and interactive video. Better courses and curricula are the result of our Challenge and Capacity Building Grants Programs that encourage innovative curriculum design and course content. And diversity means reaching out with our Multicultural Scholars Program to those allied institutions which have traditionally educated large numbers of African American, Native American, and Hispanic students.

Payoff

The CSREES is working hand-in-hand with our nation's colleges of agriculture and natural resources to keep us at the cutting edge of professional education. Consider these examples of challenges met in courses and curricula:

- Southern University's College of Agriculture and Home Economics, in close cooperation with the Forest Service, has developed **curriculum and a bachelor's degree program in Urban Forestry**. Sixty students are enrolled in this timely curricula geared to meet the needs of an increasingly urbanized society.

Planting the Seeds of Knowledge...

- Providing a perfect example of new and needed curricula is the University of Arkansas, Pine Bluff. Through three successive projects in FY 1990, 1992, and 1993, UAPB has developed the **nation's first bachelor's degree program in Regulatory Science**.
- The University of Minnesota, using funds from a Challenge Grant, developed and taught a series of **decision case studies** in farming systems. The case studies were developed in collaboration with decision makers on farms and in farm organizations, thus dealing with the **very latest challenges facing American agriculture**. A national conference is scheduled to help disseminate the results of these studies to a variety of colleges and universities throughout the nation.
- The University of Illinois developed an innovative **introductory course for new freshmen on the great issues facing agriculture**. The course reaches several hundred university freshmen each year.
- The Iowa State University College of Agriculture has developed a **model ethics institute which deals with basic principles in applied ethics** as they relate to food and agricultural science. Using funds from a Challenge Grant, the Iowa State Institute has assisted in establishing similar institutes at the University of Illinois and other leading land-grant colleges of agriculture. Now, hundreds of students in agriculture and natural resources majors are grappling with the real world ethical issues facing our society.
- Our faculty and scientists must expand their teaching skills and methods and constantly update their scientific expertise. **Teaching improvement workshops have done the job**. Following the USDA/ National Academy of Sciences 1991 National Curriculum Conference, the higher education system launched a series of faculty development workshops. These workshops, held annually in each of four regions, have enabled almost 500 faculty to share successful teaching and curricular innovations and approaches.

Genetic Enhancement: Making the Most of Nature



The value of genetic enhancement is incalculable. How do you place a price on the life of a child spared from a debilitating or deadly disease, or foods that enable more Americans to live longer, healthier lives, or a cleaner environment?

What Works

Genetic enhancement is nothing more than broader use of the natural weapons many plants and animals possess to fend off pests and diseases and to survive adverse conditions. Nature has already provided the weapons, but they're not always powerful enough or in the right place at the right time. Genetic engineering is simply finding these tools and putting them where they are most needed.

Genetic enhancement has already touched a number of familiar crops: wheat that resists diseases and allows farmers to use fewer herbicides; lettuce that can tolerate herbicides, freeing farmers from high labor costs of hand-hoeing fields; and cotton with a natural toxin to combat caterpillar-type pests such as bollworms.

Payoff

Despite its high-tech, science-fiction image, genetic engineering has a very human face. Consider these examples:

- **Juice isn't the only red flowing on tomato farms:** Insects and fungi cost U.S. tomato growers about \$300 per acre in chemical treatments, with another \$50 per acre for weed control. Now some tomatoes can help fight back. ARS researchers in Maryland have genetically engineered a natural self-defense gene in tomatoes to include an on-off switch activated by insects' chomping. The self-defense gene cranks out quantities of a hormone called cytokinin — harmless to humans, but unappetizing to tomato hornworm caterpillars.
- **The fungus that caused the devastating 1840s Irish potato famine is back,** with a new, tough look. Chemicals can help fend off the fungus, but at an estimated cost of \$100 per acre, leaving potato farmers facing a protection bill of \$80 million annually. Purdue scientists have a more natural weapon — a potato genetically engineered to resist the A2 variation of the fungus *Phytophthora infestans*. The researchers inserted a natural plant gene that produces a protein called osmotin, deadly to *P. infestans*.

Genetic Enhancement...

- **The world's most complete genetic maps of cattle and pigs**, developed by federal and university researchers, will help reveal which genes in livestock cause a particular animal's meat to be lean or give that animal unusual disease resistance. Farmers should be able to use this information within the next 5 to 10 years to select the animals they grow for the nation's meat supply.
- **An electric shock that lasts a fraction of a second** can cut months or years off the time required to move improved crops onto the market. Researchers in Maryland developed a technique called electroporation in which pollen cells are shocked just long enough to allow insertion of new genetic material from other plants, carrying with it valuable traits. Pollen with the transferred genetic material can be placed on a flowering plant to produce seed. The technique should work for any flowering crop, such as apples, cherries, and squash.
- **University scientists in Florida** are the first to genetically engineer ricin, a powerful cancer-fighting compound. The scientists engineered a tobacco plant that produces the compound that destroys cells and has tremendous therapeutic possibilities for cancer and HIV-infected patients. Approximately one out of every 20 Americans is now under medical care for cancer, and an estimated one in 250 is infected with HIV.
- **It's said consumers pay twice** for every piece of produce they purchase — once for the item they bought and once for an item that spoiled before it could be sold. As much as half of all fresh produce harvested in the U.S. is lost to spoilage, much of that due to ethylene, a natural ripening gas given off by produce. Agricultural Research Service scientists in California have "built" a gene that stops ripening of flowers and plants by blocking more than 99 percent of ethylene production. Companies have obtained licenses to use the gene in crops including tomatoes, broccoli, cucumbers, peppers, strawberries, watermelon, avocados, nectarines, pears, and peaches.

Animal Health and Wealth



Every consumer pays the price for animal diseases in the form of higher costs for food, leather goods, and other products from animals.

Costs That Count

Food animal diseases in the U.S. cost \$18 billion annually — about \$72 per year for every man, woman, and child in America. If outbreaks of foreign animal diseases such as African swine fever or foot-and-mouth occurred in the United States, the expense would skyrocket: A single outbreak of foot-and-mouth disease in the U.S. would cost an estimated \$20 billion in control, eradication, and lost production.

Animal disease can drain dollars further through lost trade. A “minor” outbreak of African swine fever — confined to a single state — could rob American farmers of an estimated \$200 million in export sales.

Biotechnology offers powerful weapons for disease prevention and early diagnosis that would have been unimaginable only a decade or two ago. For example, researchers in Iowa and Texas have produced genetically modified vaccines against brucellosis, a disease that has plagued U.S. cattle herds for 150 years and costs American cattle growers \$30 million annually. Growers have rejected previous vaccines because of difficulty in distinguishing between an infected animal and one that’s been vaccinated. The new modified vaccine is minus a distinguishing protein, solving the vaccinated-versus-infected dilemma.

Disease control is only half of the animal research story. Federal and university scientists also are working together to reduce stress and improve animal well-being. Research has ranged from breeding laying hens better suited to close quarters — birds that fight less, live longer, and lay more eggs — to devising grooved dairy barn flooring to prevent cows from falling.

Payoff

Healthy animals are a plus for everyone who depends on livestock and poultry for food, clothing, and other goods. Some examples of research to ensure a steady supply of those animals:

- **Federal and industry researchers** worked together on cloning proteins to boost white blood cells and help chickens naturally fight parasites that cause *coccidiosis*, a disease that costs U.S. poultry producers \$450 million annually. The cloned proteins stimulate production of white blood cells that naturally kill the invading parasites — a task where traditional vaccines fall short. Researchers can grow the cloned proteins in harmless

Animal Health and Wealth...

bacteria for mass production. Then birds can be vaccinated with both proteins and anti-coccidial vaccines, splitting the burden of protection between nature and man-made products.

- **Nature is a key player** in research in Indiana, where Purdue University scientists have shown separating pigs from their mothers within three weeks is more effective at keeping piglets healthy than medicating pregnant sows or baby pigs. Pigs are born essentially disease-free, but can contract diseases such as *streptococcus suis* from their mother even if she's been vaccinated before their birth. Early weaning and separation works for both large and small producers, and could save U.S. farmers and pork producers as much as \$500 million annually in vaccinations and antibiotics.
- **When somatic cell counts** in dairy cows' milk go up, milk production goes down — bad news for farmers and cost-conscious consumers alike. Higher numbers of somatic cells indicate mastitis infection. University researchers in Wisconsin developed a rapid, low-cost somatic cell count for early detection of mastitis, before infections become more costly and difficult to control. Reductions in somatic cell count have been linked with a \$50 million boost in dairy farm net income in Wisconsin alone because of improved cow health, increased milk production, and premiums paid to producers for higher quality milk.
- **Cleanliness is more** than a nice habit — it's good economic sense. Generation after generation of chickens grown in Georgia under special filtered-air positive pressure have lived free of disease without costly vaccinations or medicines. The secret: Twice-filtered air, ensuring no germ-bearing dust gets in. As an extra precaution, workers in the houses stay away from other poultry, birds eat feed that's been heated, and house floors are slotted for daily disposal of manure.
- **Marketing's out of the question** for pigs infected with *pseudorabies* in several states, including Iowa, the nation's leading hog producer. That's one of the ways the *pseudorabies* virus costs U.S. pork producers about \$60 million annually. *Pseudorabies* kills young pigs and causes reproductive failure in pregnant sows. A new genetically engineered vaccine uses a watered-down version of the virus. Iowa State researchers deleted the genes that help the virus grow and go dormant for subsequent sneak attacks.

Making More out of Much: New Uses of Agricultural Products



Mountains of grain in the Midwest. Rivers of milk flowing at too-low prices for farmers, producing cheese giveaways. Can't somebody do something with these resources?

You'd be surprised what they can do — and already have done.

In 1990 alone, 12,000 new specialty food products were developed, feeding a \$13 billion business. And that's just the beginning. Experts expect a 20-percent increase in specialty sales.

But an agricultural product doesn't have to grow up to be food. Soybeans can become fuel for buses, dead chickens can turn into compost, a plentiful tree fungus can tackle cancer, and grain starches can turn into just about anything.

The U.S. food industry leads the world in its ability to convert raw commodities to finished products and to deliver food and products to consumers in the safest, most convenient, and highest value-added manner.

Enhancing products or developing food or non-food products from raw commodities employs 1.5 million Americans. It contributes \$145 billion in added value to the economy.

When a raw agricultural commodity really wants to make something of itself, it relies on the professionals from USDA and land-grant universities to discover the possibilities.

Here are just a few examples of what scientists are doing to turn agricultural products into food and non-food items:

Payoff

- **New uses, new ideas.** A Michigan bioprocessing center funds projects that find new uses for agricultural products, including using natural flavor compounds to control decay in fruits and vegetables, creating packaging films from soft wheat flour and milk solids, and producing saffron in a bioreactor.
- **Bacteria and fungi do their part.** Microorganisms are being coaxed into producing new products from ag commodities and their by-products by South Dakota researchers. Ethanol plants are on-line in South Dakota. And a road de-icer, biodegradable packing peanuts, and tasty cookies are in the advanced discovery stage. The impact is a 5-cents-per-bushel increase in the price of corn for the producer, or \$15 million per year in South Dakota alone.

Making More out of Much...

- **Pass the cappuccino.** ARS has teamed up with a New Orleans company to market carbonated beverages made from milk. A market for carbonated milk could reverse the decline in milk consumption, since U.S. consumers drink 280 billion containers of beverages annually and the soft drink market is expected to grow by 8 percent this year.
- **Grains to grand prix.** Cushions, running shoes, even parts of lightweight airplanes can be made from corn and soybeans. Missouri engineers developed a process that reduces the use of petroleum-based products and produces a flexible product for car seats or carpet pads. With a little adjustment the substance hardens for home insulation or sailboat parts.
- **Soybean crayons — naturally.** Three Purdue University students designed a crayon using soybeans that's petroleum free and composed entirely of biodegradable materials. The crayons are nontoxic and washable — user-friendly for kids.
- **Super Slurper doing swell.** The absorbent material that swells as it gels has been slurping away for more than 20 years. Made from starches in agricultural products, the gel has been used in diapers, bandages, in fields to replace liquid ammonia, as a seed coating, and to clean up pesticide spills. This ARS technology is made with natural starch.
- **Yesterday's news.** Five pounds of shredded newspaper and one bushel of soybeans make 22 board feet of Environ, a material developed in Ohio that looks like granite and can be used like fabricated or natural wood. It can be used for counter tops, tile, flash boards, and more.
- **Do you smell french fries?** Soybean growers are already producing soydiesel, now being used in buses in 43 U.S. cities. A Missouri engineer has driven his soydiesel truck all over the country. The smell of cooking french fries announces his arrival.
- **New crop coming.** Many states, including most of the Midwest, portions of the South, Idaho, New York, and Washington, are getting into the canola growing business. Colorado extension investigated the feasibility of growing this high-oil grain with funding support from the Colorado State Department of Agriculture. The study resulted in a 10,000 acre contract. Projected production value is estimated at \$3.5 million per year.

A World of Markets — A Competition



It's 5 a.m. in mid-America. As the rising sun shines into his window, an Iowa corn farmer intently scans his computer screen for the up-to-the-minute market report for Germany. The international trade arena isn't just for the big boys. With the help of agricultural research and extension, small farmers can also take advantage of global trade opportunities. But they still need our help.

The World Is Our Oyster

Most businesses today have to operate in a tough global environment to survive. Trade agreements such as GATT and NAFTA have made it easier for them to do so. For example, since NAFTA was implemented last year, U.S. agricultural exports to Mexico have increased 19 percent — an extra \$400 million to the U.S. When NAFTA is fully implemented, the U.S. will increase agricultural exports to Mexico by \$2 billion annually.

But the U.S. still must invest funds in agricultural research and extension efforts to help producers, large and small, increase their cost and marketing efficiency and to help lawmakers make sound trade policy decisions.

Here's how USDA and land-grant university-based science and education helps companies and individuals get a competitive edge:

- Improve quality of raw products to meet desires of international customers.
- Develop processing methods tailored to international markets.
- Increase the proportion of exports that have value added through processing.
- Develop improved transportation and storage of perishable products.
- Develop new international marketing strategies.
- Provide policy options for international trade.
- Facilitate international entrepreneurship for small and new businesses.

Payoff

- **Nothing to beef about.** Discoloration of fresh beef costs the cattle industry \$1.1 billion annually. But Colorado agricultural researchers found supplementing cattle feed with small amounts of vitamin E helped minimize those losses. The biological properties of vitamin E increase the shelf life of beef by two days, regaining up to \$1 billion annually for the industry. Lengthening the shelf life also is expected to help increase the U.S. market share in Japan and other countries, where the flavor of U.S. beef is preferred but shipping reduces the cherry-red coloring consumers perceive as top quality.

A World of Markets...

- **Virus test helps swine exports.** Some countries require imported swine to be free of *transmissible gastroenteritis* virus, the cause of major economic losses in the world swine industry. But tests couldn't tell the virus from the similar but less damaging *porcine respiratory coronavirus*. Ohio State scientists studied the problem and eventually developed a new test that tells the two viruses apart. It's the only one like it in the country and will increase U.S. swine exports.
- **Nay to gray in wood.** Mississippi State researchers have developed cost-effective treatments to control gray stain in wood, which will save several million dollars per year and will improve the potential for increased export markets. Control of these stains has the potential of increasing the value of some hardwoods by as much as \$19 million annually.
- **Tastier beans.** Of the 30 million metric tons of soybeans produced each year in the U.S., humans eat about 2 percent; the rest is fed to animals. Purdue scientists say soybean producers lose out on millions of dollars in potential world food markets because U.S. soybeans don't taste good. They are enhancing the taste so soybeans can compete in the foreign market.
- **Company growth.** The University of Nebraska's Food Processing Center provided technical assistance for 69 U.S. companies competing internationally and marketing assistance for more than 150 firms. Between 1984 and 1994, the number of food processing companies in Nebraska grew from 220 to 390, a 50-percent increase. Employment in Nebraska food processing companies grew from 24,950 to 34,000 during the same period.
- **Put protein punch in wheat.** Ohio State and USDA scientists are breeding soft wheat that has stronger protein. If they succeed, Ohio farmers could export more wheat and increase their income. Until now, Ohio soft wheat has been bred for weaker protein and sold locally. But wheat for export must have stronger protein.
- **Educating entrepreneurs.** Southern extension specialists helped form the Global Entrepreneurship Management Support (GEMS) program, where they educate other extension personnel and businesses about operating in a world market. In turn, these people educate others in their communities. More than 95 percent of workshop participants said the program greatly enhanced their knowledge of international marketing.

No More Fences: Agriculture and Urban America



Phoenix, Arizona, one of our ten largest metropolitan areas, is immediately surrounded by one of America's ten largest agricultural production areas. Urban and rural America are becoming one seamless fabric. Solutions developed for agriculture by ARS and land-grant universities are finding application in urban and suburban settings across the country.

The Tactics:

Integrated pest management — The knowledge and technology developed to reduce the use of agricultural chemicals in food production is being applied to urban/suburban use in lawns, gardens, parks, and athletic fields. Pest control operators adapt this technology to the urban situation, and instructions for use of these chemicals in the "city setting" have been derived from research information generated for farming applications. Thus the several million dollars per year of research and extension activity done primarily for the farm sector has major fiscal and environmental impact in urban America.

Turf and ornamentals for town — One of the fastest growing segments of production agriculture in the U.S. involves production and marketing of ornamentals and turf grasses. In a number of states, these industries now generate farm gate receipts substantially greater than the so-called traditional crops. These industries provide the green in green areas for lawns, parks, and athletic fields. Environmental and aesthetic needs of downtown and suburban areas are benefited by the research and education programs that create new genetic varieties, develop new methods of care and maintenance, and new methods of dealing with pests.

Environmental issues at the suburban - agricultural interface— Increasingly, the relatively intensive agriculture immediately surrounding many metropolitan areas uses land and other natural resources that must be shared with the suburban dwellers who attach high value to the aesthetics and environmental quality of their surroundings. Research and extension programs are developing the options and compromises that provide a workable solution to both. Improved methods of assuring water, air, and soil quality with intensive agricultural operations are examples of what is being accomplished. In a number of cases, maintaining agricultural production in lands adjacent to suburban communities is highly sought after by these dwellers.

Niche markets at the agriculture - urban interface — A number of new small businesses have emerged to develop and exploit niche markets that fill special needs of individual communities. Research and extension activities have facilitated the development of new specialty and ethnic crops and organic products, new small businesses have emerged to process and manufacture products oriented to niche markets, and new jobs have been created in rural communities by the emergence of these new businesses.

No More Fences...

Payoff

- Forest Service research assists utilities in evaluating cost-effectiveness of shade tree plantings by measuring potential energy savings and developing guidelines for tree choice and location. **Three 25-foot tall deciduous trees** near an energy-efficient residence will **cut total heating and cooling costs per year by 5 to 28 percent.**
- Purdue University agricultural researchers found that a typical urban or suburban household generated 1,500 pounds of yard waste and **1,900 pounds of other solid waste in 1990 that cost \$165 million that year. Mulching and composting can cut that to \$50 million a year.** Extension educators work to change yard-maintenance practices through "Master Composter" classes and lawn care programs such as "Don't Bag It."
- An ARS soil scientist and an Auburn University scientist work with manufacturers of pelleting equipment to process newspapers, phone books, and other waste paper. In Texas, large pellets — 2 to 4 inches long with a 3/4 inch diameter — hold down the highly erodible soil and break the wind's impact. **Perhaps 1 million acres of farmland can be kept free from erosion by this process.** City waste becomes rural treasure.
- Cooperative research between USDA and the military benefits agriculture and urban America alike. During Operation Desert Storm and the Somalia mission, **U.S. soldiers used a cream containing deet (developed by USDA)** to protect against mosquitoes and other disease-carrying insects.
- The more than **43,000 tons of processed sludge, 120,000 tons of newsprint, and 2.6 million tons of yard trash** and garbage produced each year in Dade County, Florida **are being used as improvements to the county's poor-quality limestone-based soils.** The wastes help develop and maintain organic matter in the soil, increasing its productivity.
- The Master Gardener program, operated nationwide by volunteers trained and managed by Cooperative Extension, provides vegetables, fruits, and ornamentals for city participants often unable to afford such items. In Philadelphia, **470 urban food gardens on more than 2 million square feet generated about \$2 million worth of produce in 1993.** The 1,000 Kansas Master Gardeners implement extension horticultural programs in 11 urban counties; last year alone 175 new Master Gardeners volunteered to work 9,275 hours, worth almost \$40,000 by minimum wage standards.

Giving the Grow to Rural Communities



Some rural communities are finding new ways to get back into business. Their economies are on the grow again as a result, and people are moving back. Communities want to do it right, make it all last. Doing this successfully will mean that industry and people can coexist in livable small towns away from city-centered concentrations. Better air, better water, stable employment, a reliable work force, sound economy. Nice places to live and work.

Rural Life

Ninety percent of farms and ranches depend upon off-farm income, so the health of agriculture is tied to the diversity of the community's economic base. Manufacturing, mining, farming, and other goods-producing industries — historically the mainstays of rural economies — lost 522,000 rural jobs between 1979 and 1991. These job losses have been more than offset by job gains in service industries — business and recreational services, retailing, local consumer activities — which created almost 2.8 million rural jobs between 1979 and 1991. Population growth rates in rural counties are about double 1980s growth rates.

Rural communities are looking to harness new growth and convert it into long-term gains, avoiding ghost-town and boom-town extremes, and offering instead fine places for people to live and work long-term. University-based agricultural scientists and extension specialists are showing communities some ways to do this, providing an array of analysis, planning, and development tools which communities can use to take control of their growth.

Many rural communities are enjoying steady growth, finding ways to revitalize businesses and hang onto jobs, or to bring in more jobs by retooling old businesses or attracting new ones. Along with new businesses and more people come demands on a community's infrastructure — medical facilities, schools, and other community services. Communities are learning to deal with these.

Payoff

Some examples:

- In five rural New Mexico communities, public and private agencies are cooperating in a business retention and expansion program developed at the land-grant system's Western Regional Development Center. Community leaders visited local employers to find out how their communities could help retain or expand local businesses, and then addressed the issues identified. This helped **double revenues and increase the jobs offered by a Portales, NM peanut processor** by the equivalent of 50 full-time employees. Overall, the business expansion and retention **program brought about 466 jobs to Portales at a cost of about \$134 per job.**

Giving the Grow to Rural Communities...

- About 1 percent of the dairy farms in Pennsylvania go out of business each year, resulting in an annual loss of 130 farms and more than 450 jobs in rural areas. A Pennsylvania Extension Service program is teaching good farmers how to also be good business managers. **This can increase an average 60-cow dairy operation's annual profits by as much as \$5,040**, making the farm more likely to survive and helping rural communities maintain farm-based jobs.
- In rural South Florida, communities have been hard-hit by Hurricane Andrew, as well as fierce competition from foreign and domestic growers. To help return to competitiveness, Florida extension staff members are helping **farmers produce new tropical fruits** such as sugar apples, carambola, lychees, passionfruit, guavas and papayas.
- Texas extension agents train community leaders to assess local resources and develop strategic plans for their community's economic growth and quality of life. For example, a **quail hunting cooperative** developed in one Texas county, in response to a plan showing it to be feasible, **is helping landowners double their income** from hunting leases and adding \$130,000 annually to the county's economy.
- An innovative aquaculture program in rural Florida is helping communities survive. In rural Levy County, for example, **extension specialists helped more than 170 displaced oystermen use aquaculture leases and learn to farm clams**, saving local jobs.
- Rural areas in Georgia need primary care physicians. Georgia extension efforts have brought the medical community and rural communities together in an annual medical fair that matches resident physicians and medical students with small communities. In the fair's 16-year history, **265 physicians have been placed in Georgia communities with a 90-percent retention rate**. The location of these doctors has made an economic **impact of more than \$25 million**.
- The Kansas Extension Service provides a one-stop point of contact to help Kansans find the economic, business, and rural development assistance needed to start new businesses, create jobs, and foster rural development. **The program in the past year has helped retain 43 businesses and recruit 57 businesses**, bringing 380 jobs to rural Kansas.

Help for Our Future Is a Family Affair



America's youth and families — rural and urban — are more vulnerable than ever.

- Too many babies are born to unwed teens.
- Low birthweights threaten lifelong health.
- Too many youth lack self-esteem, education, and job skills.
- Divorce, poverty, high health costs cause family stress.
- Working parents struggle to afford good childcare.

Help for Kids and Parents

Extension specialists and researchers offer plenty of programs for families. And society reaps a nice payoff.

Nationwide, the Cooperative Extension Service's youth development program enrolls 5.6 million young Americans. The program helps prevent teen pregnancy, substance abuse, and violent behavior. It fosters self-esteem and improved academic performance. A U.S. House of Representatives Select Committee on Children, Youth and Families shows a return of \$6 to \$8 for every \$1 spent on prevention programs to keep youth on track.

The societal payoff for every teen mother who participates in extension's prenatal education programs is even greater. Those whose baby's birthweight is a normal 5 1/2 pounds or more save \$15,000 in initial medical costs and \$400,000 in health care in the baby's lifetime.

Any of those babies who grow up and run into trouble with the law may be sent to 4-H by the court. 4-H youth development programs offer a creative solution to problems of alcohol, drug abuse, and impaired driving.

And for millions of mid-life and older people raising families, extension staff provide financial education to help these people stretch their dollars and make effective financial decisions.

There's more — a lot more. Let's look at a few examples from around the country.

Payoff

- **Neonatal mortality cut in half.** The "Have a Healthy Baby" program started in Indiana and now, in 33 states, provides pregnant teens with nutrition education before and after birthing. The program is credited with reducing deaths per 1,000 live births from 5.7 to 2.8. Days of hospitalization (\$2,000 a day) for low birthweight infants were reduced from 30 days to 13 days.
- **Now they do their homework.** Connecticut's extension school-age childcare program showed a 25 percent increase in homework completion, 23 percent in school attendance and 20 percent improvement in grades. Children ages 5-12 in Utah's CARES project do their homework, write in journals, read literature, and participate in arts and crafts and recreational activities before and after school.

Help for Our Future Is a Family Affair...

- **And they eat better, too.** *Una Vida Mejor*, an extension program to help economically disadvantaged people in the colonias and towns along the Texas-Mexico border, strengthens family leadership, esteem, and self-sufficiency. Studies show those in the program increased parent-child communication 86 percent, school attendance by 82 percent, and healthier diets by 82 percent.
- **Study changes state divorce law.** Ohio State researchers studied the financial effects of divorce on women and children. Their results helped create a model program for the Franklin County Domestic Relations court and were used to revise Ohio child support guidelines and the state's divorce law.
- **Where have all the doctors gone?** The Department of Health and Human Services has identified 2,448 mostly rural areas with shortages in primary care professionals, including general physicians, nurses, dentists, and mental health professionals. Compounding the problem is that more than 8 million rural residents have no health insurance. Alabama researchers surveyed doctors and their patients to find out why physicians would leave their rural practices. Physicians said the main reason they would leave was lack of backup; they had to be on call 24 hours a day. Patients said if their doctors left, they would follow them if possible and were willing to increase their average commute from 14 miles to 36 or more miles.
- **A shot in the arm.** A volunteer immunization clinic in Beatrice, Nebraska, operated by a certified nurse and extension volunteers, gave children 3,128 immunizations worth \$88,000 last year. Studies show that universal vaccination with Hib at 18 months would save \$207 million in health care costs.
- **"PowerPay" reduces debt.** This program, developed by Utah's Extension Service and used throughout the U.S. and 26 countries, lets consumers get out of debt faster and save interest dollars. A sampling of 117 users reports combined savings of more than \$26,000.
- **Volunteer power.** Last year, more than 13,000 youth and adult volunteers were involved in community youth-at-risk projects funded by the Cooperative Extension System. They contributed 487,000 hours valued at \$5.6 million.

Appendix

Developing the Report

The Joint Council Accomplishments Task Force was formed to prepare this report. Leadership from the State Agricultural Experiment Stations and Cooperative Extension Service joined with counterparts from ARS, CSREES, and U.S. Forest Service to form a national task force to develop the criteria for writing the report; science writers representing all parts of the partnership met in a national workshop during March 1995 to compile and write the specific examples.

The final report drew on inputs from across the system of more than 500 recommendations which cited specific accomplishments and impacts of the programs over the last five years. Nationally recognized experts from across the system were engaged as advisors as the report was being prepared.

The final report was displayed in two formats: (1) the Accomplishments Report as contained in this document and (2) the same set of accomplishments prepared as single entity briefing papers (one page front-and-back) to be used for broader communication.

Members of the Joint Council Accomplishments Task Force:

Gale Buchanan, cochair
University of Georgia

Andy Duncan
Oregon State University

Robert Gilliland, cochair
Utah State University

Myron Johnsrud
NASULGC

Neville Clarke
Southern Association of Agricultural
Experiment Station Directors

David A. King
Purdue University

Pat Calvert
Cooperative State Research, Education
and Extension Service - USDA

Susan Hess
U.S. Forest Service

Robert Norton
Agricultural Research Service-USDA

Science Writers Contributing to the Accomplishments Report

Dave King
Writing Team Leader
Purdue University

Katie Smith
Auburn University

Judith Bowers
Cooperative State Research, Education and
Extension Service - USDA

Sandy Hays
Agricultural Research Service-USDA

Susan Hess
U.S. Forest Service

Lynette James
Texas A&M University

Joe Marks
University of Missouri

Len Carey
Cooperative State Research, Education and
Extension Service - USDA

Claire McCabe
University of Delaware

Janet Rodekohr
University of Georgia

Acknowledgments:

Appreciation is expressed to the Directors of State Agricultural Experiment Stations and Cooperative Extension Services for providing the scientific writing staff who participated in this effort. Similarly, thanks are expressed to the CSREES, ARS, and USFS for their active participation in all aspects of this project. Funds for travel of state-based science writers were provided by the Joint Council for Food and Agricultural Sciences.

Final organization, layout, and creation of this report was completed at Purdue University by Dave King and the Purdue Department of Agricultural Communication Service staff.

